thimble on one of the fingers. This deprived her of sight for ten days, after which, having had a severe hysterical paroxysm, her vision returned, but convulsive and hysterical sensations still remained, from which she was not relieved till six weeks after. This case, which the author conceives to be a proof that the electric fluid is capable of suspending the functions of the optic nerve without altogether destroying them, suggested the idea of some further experiments, with a view to ascertain whether electricity could be so applied, by artificial means, as to destroy the power of contraction possessed by nerves. The effects seemed to prove the negative; but it is owned these experiments were made under circumstances which did not inspire much confidence.

It appears, in general, that these experiments, and the observations deduced from them, materially illustrate an action or power inherent in the nervous chords, capable of producing the symptoms which occurred in the cases here related; and that the once favourite hypothesis of a nervous fluid, does not give a satisfactory solution of those nervous agitations, which only proceed for some way in the course of a nerve, and are there arrested without being allowed to proceed to the brain. The disorder known by the name Tic Douloureux, is given as an example of the manner in which spasmodic tremors are propagated along the nerves. And a case of a locked jaw occasioned by an injury to the thumb, is lastly mentioned, which corroborates all that has been said concerning the first case mentioned in this paper.

The Bakerian Lecture. On the Mechanism of the Eye. By Thomas Young, *M.D.F.R.S.* Read Nov. 27, 1800. [*Phil. Trans.* 1801, *p.* 23.]

The copious contents of this lecture relate chiefly to the power possessed by the eye to accommodate itself to the perception of objects at different distances, concerning which a variety of opinions have been entertained.

After some general considerations on the sense of vision, from which it appears that though the extent of the field of perfect vision for each position of the eye be not very great, yet there is reason to believe that its refractive powers are calculated to take in a moderately distinct view of a whole hemisphere: the author, aware how essential it is in an inquiry of so delicate a nature to proceed upon solid, and as far as possible incontrovertible grounds, delivers a set of dioptrical propositions (eight in number), each accompanied by some scholia and corollaries, from which he means to deduce the principal inferences brought forward in the sequel of the lecture.

The nature of these can only be here intimated by their different enunciations, some of which may appear elementary, yet lead to results of a less obvious nature. They are as follows;—1. In all refractions the ratio of the sine of the angle of incidence to the sine of the angle of refraction, is constant. 2. If between two refracting mediums a third medium, terminated by parallel surfaces, be inter-

posed, the whole refraction will remain unchanged. 3. At the vertex of a given triangle to place a given refracting surface, so that the incident and refracting rays may coincide with the two sides of the triangle joined at the vertex. 4. In oblique refractions at spherical surfaces, the line joining the conjugate foci passes through the point where a perpendicular from the centre falls on the line bisecting the chords cut off from the incident and refracted rays. 5. To find the place and magnitude of the image of a small object after refraction at any number of spherical surfaces. 6. To determine the law by which the refraction of a spherical surface must vary, so as to collect parallel rays to a perfect focus. 7. To find the principal focus of a sphere or lens, of which the internal parts are more dense than the external. And lastly, to find the nearer focus of parallel rays falling obliquely on a sphere of variable density. How these various propositions, both problems and theorems, apply to the structure and functions of the eye, will be manifest to those anyways acquainted with investigations of this nature.

As the focal distances of the eye, whether permanent or variable, must be one of the principal data upon which this inquiry is to proceed, an instrument for readily determining these distances could not but be a very essential desideratum. Although due praise be here given to Dr. Portenfield's optometer, invented for that purpose, Dr. Young, thinking it capable of considerable improvements, describes another apparatus of a more simple construction, and much more convenient and accurate in its application. Its principle depends on the circumstance, that when we look at any object through two small holes within the limits of the pupil, if the object be at the point of perfect vision, the image on the retina will be single; but in every other case the image, for reasons previously stated, will become double, and will appear as two lines crossing each other in the point of perfect vision. Thus we see that this point of intersection coincides with that of perfect vision, and by the help of a lens, and of a scale deduced from one of the corollaries of the fourth proposition, we are enabled to determine the focal distance of every eye. The mechanical part of this apparatus must be learnt from the figures which accompany the lecture.

On these principles, and with this instrument, the author proceeds next to investigate the dimensions and refractive powers of the human eye in its quiescent state, and the form and magnitude of the picture which is delineated on the retina. This he has performed chiefly on his own eye; and he has in general grounded his calculations on the supposition of an eye nearly similar to his own. The various expedients he has used for obtaining accurate measurements, is perhaps not the least interesting part of the lecture. Nor will the series of general observations on the structure and functions of the eye, into which the author enters circumstantially, be found of less moment and curiosity. Among these may be noticed the obliquity of the uvea, and of the crystalline lens nearly parallel to the uvea, with respect to the visual ray, whereby a distortion of the focal point is produced

in some eyes, and certain instances of oblique vision may be duly accounted for; also the different refractive powers of the crystalline lens at the centre and near its surface, the former after death being to that of water in the proportion of 21 to 20, and gradually decreasing till at the surface it becomes equal to that of the surrounding medium, thus producing a mean refraction for the whole lens, considered as a body of equal density, in the proportion of 14 to 13 when compared with that of water. We also find here that the whole extent of perfect vision is little more than 10°, or more strictly speaking, that the imperfection begins within a degree or two of the visual axis, and that at the distance of 10° or 15° it becomes nearly stationary, until at a still greater distance vision is wholly extinguished; but that the motion of the eye, at the same time, has a range of about 55° in every direction, so that the field of perfect vision, in succession, is by this motion extended to a circle of 110° diameter. The advantage also of the spherical form of the eye, not only for motion but also for vision, is illustrated by diagrams. These few observations are here inserted not as a just delineation of this important part of the lecture, which cannot be condensed within our limits, but as a few examples of the sort of information the reader may expect to derive from it.

In a following section the author proceeds to inquire how great are the changes which the eye admits, and what degree of alteration in its proportions will be necessary for these changes, on various suppositions;—1. A change in the radius of the cornea. 2. A change in the distance of the crystalline lens from the retina. 3. These two causes acting conjointly; and 4. Some alteration in the figure of the lens itself. A minute inquiry follows next, which of these changes actually takes place in nature: and here a variety of experiments are mentioned, contrived for the purpose of deciding on the truth of each of these suppositions. The object of the first series of these experiments, the results of which were directly inferred from the effects of immerging the eye in water, is to ascertain the curvature of the cornea in all circumstances; and from these results it appears that the cornea is not concerned in the accommodation of the eye. A similar investigation is instituted to inquire whether any alteration in the length of the axis of the eye, which would affect the distance of the lens from the retina, actually takes place in nature. And here, too, the results are, that it is highly improbable that any material change in the length of this axis is ever produced, and that it is almost impossible to conceive by what power such a change could be effected. The opinion of the joint operation of these two causes, which had derived great respectability from the ingenious and elegant manner in which it had been treated by Dr. Olbers of Bremen, and from being the result of the investigation of Mr. Home and the late Mr. Ramsden, is, lastly, shown to be inconsistent with the experiments related in this paper.

We now come to the important section, in which the author inquires into the pretensions of the crystalline lens to the power of altering the focal length of the eye. The grand objection to the

efficacy of a change of figure in the lens, was derived from various instances of persons, who, after they were deprived of that part of the organ, still retained the faculty of accommodation. The result of this inquiry was, contrary to expectation, that in an eye deprived of the crystalline lens, the actual focal distance, as ascertained by the optometer, is totally unchangeable: for the proofs deduced in favour of this assertion, the author acknowledges himself indebted to Mr. Ware, who obligingly introduced him to several of his patients on whom the operation had been performed. Having thus, then, pointed out the inconveniences attending all the other hypotheses, and some imperfections in the experiments adduced in their favour, and having removed the principal objections to the opinion of an internal change of the figure of the lens, the Doctor proceeds to describe some experiments which he conceives come very near to a mathematical demonstration of the existence of such a change, and likewise in a great measure explain its origin and the manner in which it is effected. The results of these experiments are deduced from the different distribution of light in the image of a lucid point on the retina, according to the different states of the eye; and inferring thence, on the mathematical principles above laid down, what form of the lens will account for those different impressions. It is here acknowledged that the mere action of the external coats of the lens, does not, as was stated by the author eight years ago, afford a satisfactory explanation of the phænomenon. It seems, however, manifest, that changes of figure take place in the lens, which can be produced by no external cause; and this seems to establish the muscularity of the lens, long since suggested by Dr. Pemberton, Albinus, and others. The words of the author on this subject are, "If we compare the central parts of each surface of the lens to the belly of a muscle, there is no difficulty in conceiving their thickness to be immediately" (or spontaneously) "increased, and to produce an immediate elongation of the axis, and an increase of the central curvature; while the lateral parts cooperate according to their distances from the centre, and in different individuals in somewhat different proportions." And an intimation is here added, that it would be worthy of inquiry, whether the state of contraction may not also immediately add to the refractive powers of the lens.

In the last section we find some anatomical illustrations of the construction and capacity of the organs of various classes of animals for the functions attributed to them. The human lens is not only ascertained to be of a radiated structure, but, on close inspection, the number of radiations is found to be ten on each side. The greatest pains were taken to trace nerves into the lens, but as yet without success. The author, however, declares his conviction of their existence, and of the precipitancy of those who have absolutely denied them; and adduces some observations in favour of this assertion. He next describes a zone, or gland, surrounding the margin of the crystalline, which he has observed in many animals, and which, from some phænomena of vision, he also infers in the human eye.

Some observations are lastly added concerning the nature and situation of the ciliary processes in various animals; also on the nature of the marsupium nigrum of birds, and the horseshoe-like appearance in the choroid of fishes; both which have improperly been termed muscular,—the former being a mere duplicature of a membrane which may be unfolded; and in the latter the whole mass being evidently of an uniform texture, the fibrous appearance which has misled some former observers being the effect of transverse fissures, or cracks, which may easily be mistaken for filaments.

The lecture concludes with a few observations on the bony scales of the eyes of birds, to which the author denies any concern in changing the focus of the eye; and on a cavity observable in the eyes of some insects which has been supposed to be in some measure subservient to this purpose.

On the necessary Truth of certain Conclusions obtained by Means of Imaginary Quantities. By Robert Woodhouse, *A.M. Fellow of Caius College. Communicated by the Rev.* S. Vince, *A.M. Plumian Professor of Astronomy in the University of Cambridge.* Read January 8, 1801. [*Phil. Trans.* 1801, *p.* 89.]

The object of this paper is to show, that we may be assured of the justness and accuracy of conclusions obtained by means of imaginary quantities, without verifying such conclusions by separate investigations, or without inferring their truth from analogy. In the first part the author premises at some length certain arguments, to show that the operations with impossible quantities must have a logic equally strict and certain with the logic that appertains to real quantities, and that the aid obtained by these quantities would be perfectly useless if such conclusions rested only on the frail basis of analogy.

The author proceeds next to show that operations with imaginary quantities are by no means mechanical, but that they are conducted according to the rules of strict and rigorous logic; and that, although strictly speaking no proposition concerning them can be true or false, yet, after the demonstrations of certain formulæ for real quantities, demonstrations with impossible quantities may be legitimately and logically conducted. The series, for instance, for the development of an exponential, when the exponent is an impossible quantity, can never, independently of certain arbitrary assumptions, be duly established; and yet, when the exponent is the sign of a real quantity, the formula for the development may be rigorously proved. With regard to demonstration, it is shown, as in the case of real quantities, it actually proceeds by a series of transformation, each proved to be the same as the foregoing, not by any arguments grounded on the properties of real quantities, but by reference to the forms certain abridged symbols are made to represent, and to the nature of the operations directed to be performed with certain signs.

After thus establishing the principle by which operations with imaginary characters are regulated, the author shows its efficacy and